ALASKA INTERAGENCY FIRE MANAGEMENT PLAN
TANANA/MINCHUMINA PLANNING AREA
AND
ENVIRONMENTAL ANALYSIS

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THE ALASKA INTERAGENCY FIRE MANAGEMENT PLAN
TANANA/MINCHUMINA PLANNING AREA

ENVIRONMENTAL ASSESSMENT COVER SHEET
-FINAL-

UNITED STATES DEPARTMENT OF THE INTERIOR
RESPONSIBLE OFFICIALS

John Cook
Regional Director
National Park Service
540 W. 5th Avenue
Anchorage, Alaska
(271-4551)

Keith Schreiner
Regional Director
Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska
(276-3800)

Curtis McVee
State Director
Bureau of Land Management
701 C Street, Box 13
Anchorage, Alaska
(271-5076)

Jacob Lestenkof
Area Director
Bureau of Indian Affairs
P.O. Box 3-8000
Juneau, Alaska 99802
(586-7171)

SUMMARY

The U.S. Fish and Wildlife Service, National Park Service, Bureau of Indian Affairs and Bureau of Land Management propose to implement the Tanana/Minchumina Interagency Fire Management Plan. The fire plan applies to approximately 31,000,000 acres of Federal, State, Native Corporation and other private lands in central interior Alaska. The plan contains four fire management alternatives or options that range from immediate and aggressive suppression to no initial attack. Implementation of the plan, which is the preferred alternative, allows for the use of cost effective strategies to reduce fire suppression expenditures, and to assure responsiveness to land manager/owner objectives.

DECISION RECORD

Adopt preferred alternative(s) as shown on Appendix E and implement special considerations (Table 9). This decision is in conformance with existing land-use plans where applicable. No significant negative impacts will occur; therefore, an environmental statement is not required.

ALASKA INTERAGENCY FIRE MANAGEMENT PLAN
TANANA/MINCHUMINA AREA
AND
ENVIRONMENTAL ANALYSIS

I. INTRODUCTION

A. AUTHORITY AND PLANNING TEAM COMPOSITION

This plan is being prepared with the approval and support of the Alaska Land Use Council (ALUC). The ALUC was formed in 1980 by a provision of the Alaska National Interest Lands Conservation Act (ANILCA).

The ALUC designated a Fire Management Project Group to organize and coordinate interagency fire management. The group is composed of representatives from Doyon, Limited (for Alaska Federation of Natives); Alaska Department of Fish and Game; Alaska Department of Natural Resources; National Park Service; U.S. Fish and Wildlife Service; Bureau of Land Management; Bureau of Indian Affairs; U.S. Forest Service Region 10; and U.S.F.S. Institute of Northern Forestry.

The Tanana/Minchumina Fire Planning Team is a working group under the Fire Management Project Group. It is composed of representatives from:

- Tanana Chiefs Conference, Inc.
- Doyon, Limited
- State of Alaska
  - Department of Natural Resources
  - Department of Fish and Game
- U.S.Department of the Interior
  - Fish and Wildlife Service
  - National Park Service
  - Bureau of Indian Affairs
  - Bureau of Land Management
- U.S.Department of Agriculture
  - Forest Service, Institute of Northern Forestry

B. GOALS AND OBJECTIVES

The purpose of this plan is to provide an opportunity for land managers within the planning area to accomplish their land use objectives through cooperative fire management. We recognize that the management options developed in this plan should be ecologically sound, operationally feasible, and flexible enough to change as new objectives, information, and technology become available.

The objectives of this plan are to ensure:

1. The coordination and consolidation of fire prevention activities, including education, regulation, enforcement, and burning restrictions.

2. Aggressive and continued suppression action on fires which threaten human life, identified private property, and physical developments.

3. A regular review to facilitate modification by individual parties or between parties with shared boundaries and/or concerns.

4. Maintenance of total control by affected land managers/owners in selecting the fire management options in the lands that they administer.

5. Identification, promotion, and (where possible) prioritization of needed research related to fire management and fire's role within the planning unit.

6. Selection of fire management options to help realize current resource management objectives in a manner which maximizes the effectiveness of each dollar spent.

7. That the treatment of options other than total and immediate suppression is as comprehensive in planning, design, and operational guidelines as the treatment if total and immediate suppression is planned.

C. GENERAL GUIDELINES

The plan was prepared within these general guidelines:

1. The boreal forest is a fire-dependent ecosystem, which has evolved in association with fire, and will lose its character, vigor, and faunal and floral diversity if fire is totally excluded.

2. The plan will be formulated under existing land ownership and land use plans. This recognizes that land ownership will change continually for several years, and that land use plans are in various stages of completion. Yearly reviews, modifications, and updates of the plan will be made accordingly. (See Section H.)

3. This plan will be implemented during the 1982 fire season.

4. The plan will replace the current policy of total suppression with a comprehensive fire management program for the planning area.

5. This plan will establish fire management options which each land manager can apply according to his own land use objectives and constraints. Each land manager is expected to incorporate changes in land use objectives into the plan each year. Selection of a fire management option does not preclude the development of prescribed burning programs by any land manager/owner.

6. The functions of allocation of forces, detection, and prevention will be considered and addressed as needed to accomplish objectives of the plan.

7. Cost effective strategies will be explored to reduce fire suppression costs, promote resource management, and assure responsiveness to all land managers' objectives.

D. RELATIONSHIP TO LAND USE PLANNING

This plan is not a land use plan. Rather, it is a guide to coordinate use of fire suppression forces among a wide variety of land managers and to promote a comprehensive fire management program. It does not develop land use objectives; it implements these objectives relative to fire management.

Unfortunately, land use planning has only been completed within very small portions of the planning area. Thus, specific objectives have not been developed for most of the planning area. Nevertheless, land managers are guided by basic policies and objectives which can be stated without land use planning (e.g., protection of human life). These policies and objectives provide a solid foundation for this planning effort. As more specific objectives are developed by various land managers, they will be incorporated into this plan.

The status of land use planning for individual agencies is reviewed below.

<u>Native Corporation</u> - Planning is in preliminary stages of collecting information. No specific planning is underway although the need is recognized to promote effective use of resources.

<u>State of Alaska</u> - The State has completed land use allocations in most of the area. General land use planning for the eastern part of the area has begun, ant is scheduled for completion in mid-1982.

<u>National Park Service</u> - Comprehensive land use planning has begun for Denali National Park and Preserve.

<u>Fish and Wildlife Service</u> - The Nowitna Refuge was added to the Fish and Wildlife Refuge system by P.L. 96487. No specific land use planning has been done.

<u>Bureau of Land Management</u> - The Utility Corridor Land Use Plan, covering a 6 to 24 mile wide strip along the Trans-Alaska Pipeline was approved on September 29, 1979. The Anchorage District completed a plan for the southwestern part of the area in 1981. The balance of BLM land is not covered by a land use plan.

E. CURRENT FIRE MANAGEMENT POLICY

All participating agencies subscribe to a policy of immediate and aggressive initial attack, followed by aggressive, sustained attack until the fire is suppressed. This policy can only be modified when mandated by safety consideratlons or lack of men/equipment, or when an approved fire management plan is in effect. The Tanana/Minchumina Fire Management Plan constitutes such a plan.

The USDI, Bureau of Land Management and the State of Alaska currently provide all fire suppression forces in the planning area. The State protects the northeastern corner of the area, including State, Federal, and private lands. The BLM protects the remainder of the planning area, including State, Federal, and private lands.

While the State and BLM still provide all suppression forces, the policies and objectives under which fire is managed are changing radically. The National Environmental Protection Act, Federal Land Policy and Management Act, Endangered Species Act, and other laws have stimulated the change in policy from fire suppression to fire management. In addition, lands have been transferred from the BLM to the State of Alaska, the U. S. National Park Service, and the U. S. Fish and Wildlife Service, according to the provisions of the Alaska Statehood Act (1958), and the Alaska National Interest Lands Conservation Act (1980). The Alaska Native Claims Settlement Act (1971) gave about 44 million acres to village and regional Native corporations. Each village corporation was allowed to select from three to seven townships, while regional corporations selected varying amounts of land, according to the Native population in the region. The Act specifies that the Federal government has fire suppression responsibility on Native lands, even though these lands are in private ownership.

The fire suppression organizations are moving from a time when they had a relatively simple mandate (suppress all fires), into an era when they must respond as service organizations to the complex demands and objectives of many new and old land managers. This is the essence of the Tanana/Minchumina Plan--to provide a formal and organized transition from simple fire suppression to complex fire management.

F. PUBLIC MEETINGS

In May 1981, public meetings were held in all towns and villages located within or near the fire planning area. The objectives were to make the public aware of the plan, and to answer any questions regarding the plan content, procedures, or potential impacts.

Members of the fire planning team were divided into two groups, one to visit the northern part of the area and one to visit the south. Team members represented three to five Federal, State, or private agencies, and always included a representative from BLM Fire Management and the Alaska Department of Fish and Game. Meetings were held in Fairbanks, Ruby, Tanana, Rampart, Minto, Manley, Nenana/Anderson, Healy, McGrath, Minchumina, Telida, Nikolai, Takotna, and Medfra.

Before each meeting, team members sent announcements and/or made phone calls to the community indicating dates when the meeting would be held. At each meeting, an overview of the proposed fire management options established by the plan was given, and the opinions of local residents sought. All comments regarding the fire plan were recorded, and questions answered. Residents were encouraged to send any additional suggestions or comments to the Fairbanks or Anchorage BLM District offices.

Appendix A contains a summary of the questions which the public asked, and the planning team's response.

G. ROLE OF FIRE IN THE ALASKAN ENVIRONMENT

Fire has been a natural force in the Alaska interior for thousands of years. It is a key environmental factor in these cold-dominated ecosystems. Without fire, organic matter accumulates, the permafrost table rises, and ecosystem productivity declines. Vegetation communities become much less diverse, and their value as wildlife habitat decreases. Even some of the plant and animal species normally associated with later successional stages will find the environment unsuitable.

Fire rejuvenates these ecosystems. It removes some of the insulating organic matter and results in a warming of the soil. Nutrients are added both by ash from the fire, and by increased decomposition rates. Vegetative regrowth quickly occurs, and the cycle begins again.

An occasional fire may be critical for maintaining the viability of northern ecosystems, yet fire can also be a threat to human life, property, and valued resources. The realization that fire plays an essential ecological role, but also has a destructive potential in relation to human life and values can make the fire management decision process very difficult.

H. REVISION

This plan will be reviewed for revision yearly by a committee of land managers/owners. This meeting should take place prior to April 1 to allow fire suppression organizations to implement any changes. It will be the responsibility of the Bureau of Land Management Alaska Fire Service to manage the review process.

A land manager/owner may change the management option on any part of his land at any time between September 30 and April 1. Alterations or changes will be processed in the same manner as modifications in Cooperative Agreements. It will be the responsibility of the land manager/owner to notify adjacent land manager(s)/owner(s) of any change in the management option.

Information on land status changes, critical sites, and special concerns (such as historic and cultural sites) may be used to update the plan at any time during the year. This will be handled at the local operational level.

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II. PLANNING AREA

A. GENERAL

1. <u>Location and Size</u>

The Tanana/Minchumina Planning Area encompasses approximately 31,000,000 acres (48,000 square miles), about 1,500 square miles smaller than the State of New York. It is located in central interior Alaska (Figure 1) and is bounded on the.east by the George Parks Highway, on the south by the crest of the Alaska Range, on the west by the Big River, Innoko River, and Placerville Road, and on the north by the northern crest of the Melozitna River watershed, the Ray Mountains, and the Dalton Highway (Alaska Pipeline haul road).

The planning area is centrally bisected by the Kuskokwim River and the Yukon River, the two largest rivers in Alaska. Most of the inhabitants live along these rivers and the Tanana-River which flows into the Yukon at the village of Tanana

2. <u>Land Ownership</u>

Major shifts in land ownership are occurring and will continue for several years as a result of the Alaska Native Claims Settlement Act (ANCSA), Alaska Statehood Act, and Alaska National Interest Lands Conservation Act. The area includes 10 recognized Native villages and two Native groups awaiting approval. (Current land status is shown in Appendix D in map pocketl.) Corporate Native lands include patented, interim-conveyed, and selected designations for both village and regional corporations as well as cemetery and historical site selections. Most of the acreage is in the selected category with continual changes to interim-conveyed as the ANCSA conveyance process continues.

BLM is the interim manager for unconveyed Native selections, except for the Ruby selection inside the Nowitna Wildlife Refuge for which the Fish and Wildlife Service is the interim manager. This means that the respective agencies, acting for the Secretary of the Interior, have the final decision authority for fire protection on the Native lands.

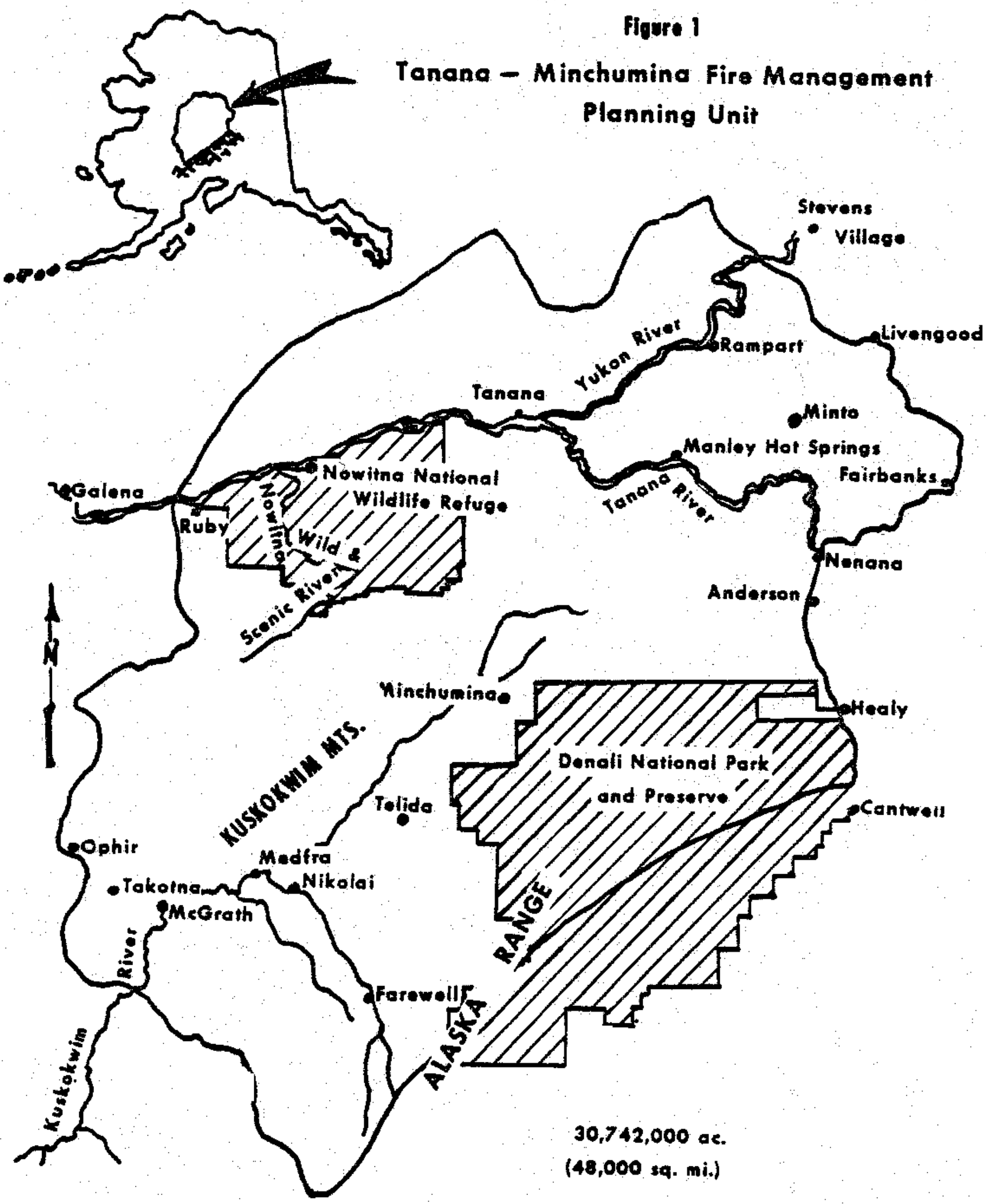
State land is in a category similar to Native lands: that is, patented, tentatively approved, or selected. Patented and tentatively approved lands are concentrated in the Fairbanks locale northwesterly to Livengood, along the Parks Highway, in the Kokrines Hills, and in the Poorman area. Elsewhere, the State lands are chiefly in the selected category. BLM is the interim manager for State selected lands.

Lands in Denali National Park and Preserve are under the jurisdiction of the National Park Service. The Nowitna Wildlife Refuge, created in March 1980, is administered by the Fish and Wildlife Service. This agency is also the interim manager for Native selections lying within the Refuge boundaries.

1Base map obtained from Arctic Environmental Information and Data Center, 707 A Street, Anchorage, Alaska.

Figure 1

Tanana – Minchumina Fire Management Planning Unit



30,742,000 ac.
(48,000 sq. mi.)

The BLM manages the remaining Federal lands outside the Park and Refuge, except for small military parcels at Clear and Takotna, and several small air navigation sites administered by the Federal Aviation Administration (FAA).

More than 300 Native allotments and about 75 other settlement claims are found across the area. Additionally, there are parcels of privately patented land. The claimants for Native allotments, Trade and Manufacture (T&M) sites, headquarters sites, and patented mining claims have possessory interests which place the claims in the same category as private land.

3. Population and Facilities

Most of the people in the planning unit live in the Fairbanks area, with a local population of about 36,000. The rest of region is sparsely populated. Twelve villages, located mainly along rivers and highways, have a total population of about 2400. A few people live outside of villages on mining claims or near areas which meet their subsistence needs.

The road net within and adjacent to the planning area is very limited. The George Parks Highway extends from near Anchorage to Fairbanks, forming the eastern boundary of the planning area from Cantwell to Fairbanks. The Elliott Highway forms part of the northeast planning unit boundary, from Fairbanks north to Livengood, and then extends southwest into the planning area to Manley Hot Springs. The Dalton Highway extends from Livengood northwest to the Ray Mountains, along the remainder of the northeastern boundary of the planning unit.

Most major facilities are located near population centers or along the road network. A variety of remote communication sites are scattered throughout the area, but they are generally located on rocky unburnable ridge tops where they are not threatened by wildfires.

B. PHYSICAL ENVIRONMENT

1. Climate

The climate is continental, characterized by long cold winters and short warm summers. Winter temperatures of -60 EF or lower are not uncommon and can be expected for extended periods of time. Summertime temperatures are relatively mild, but have reached as high as 90EF. Freezing conditions have occurred in every month of the year within the planning unit. Because sunlight approaches 22 hours/day in the northern portion in mid-June and slightly less in the southern portion, there is no pronounced variation in burning conditions between day and night during the peak of the fire season.

Annual precipitation is approximately 12 inches for the northern portions and 19 inches in the central and southern portions with 40 to 50 percent of this in the form of snow. Light, general rain occurs frequently during the summer months, although significant amounts are provided by thunderstorms. Thunderstorms are most frequent in the months of June and July (specific information can be found in Appendices B and C). Spring flooding occurs commonly along nearly all major rivers. Floods also can occur following periods of exceptionally heavy rainfall in midsummer.

Prevailing winds are southwesterly and tend to be closely associated with frontal passages. Severe winds often occur near the mouths of the valleys and steep gorges along the north face of the Alaska Range. These winds influence adjacent areas for up to 20 miles. Terrain also plays an important role in determining wind flow patterns in the sheltered Interior.

The basic question relative to predicting the seasonal fire weather picture was addressed to some degree in the climatological study performed for the Bureau of Land Management by the University of Alaska (Searby, 1975). The results of assessing whether or not a weather pattern would remain through a fire season, or if there would be predictable changes as a season progressed, showed wide variations of temperature and precipitation between years and during an individual season. This indicates that any predictions of seasonal or long-range burning conditions would be accompanied by a high degree of risk.

2. <u>Topography</u>

The planning unit is composed of four physiographic regions:

a. <u>Interior Alaska Lowlands</u> - This area includes broad valleys and plains between the Alaska Range and Kuskokwim Mountains, and south of the Yukon River between Ruby and Tanana. Most of these lowlands are nearly level and are interlaced with streams, sloughs, shallow lakes, and marshes. Also included are glacial outwash plains and piedmont slopes, originating in the Alaska Range.

b. <u>Interior Alaska Highlands</u> - The Kokrines Hills, north of the Yukon River, and the Ray mountains, north of the Tanana River, consist mostly of rounded hills and ridges but include some mountains higher than 4,000 feet. Parts of the area adjacent to major river valleys are as low as 300 feet.

c. <u>Alaska Range</u> - This long narrow mountain chain forms the southern boundary of the fire plan area. Steep talus and scree slopes, razorback ridges and deep valleys predominate, with many peaks higher than 10,000 feet. Huge glaciers are the source of many of the major rivers and streams which eventually become part of the Tanana, Kuskokwim and Yukon Rivers.

d. <u>Kuskokwim Highlands</u> - These uplands, in the west central part of the planning unit, include hills and low mountains. The primary portion consists of a series of rounded ridges 1,500 to 2,000 feet in elevation, separated by deep narrow valleys. A few peaks stand above the general level of the hills.

3. <u>Soils-Watershed</u>

A description of soils in the planning area can be found in the <u>Exploratory Soil Survey of Alaska</u> (Rieger et al, 1979). In general, the soils on raised areas along moraines and hills, or along major drainages, are well-drained, sandy or gravelly loams. These are the warmest, most productive, and frequently the driest sites. Severe fire can damage soils on these sites if the organic mat is thin. However, these sites usually support deciduous plant or white spruce/moss communities, which are relatively fire–resistant.

In lowlands, extensive areas are underlain by cold wet soils, usually with a thick organic mat and often with permafrost. Fire effects on these sites can vary widely with the severity of fire and the nature of the permafrost.

Permafrost is a condition in which ground temperature remains below freezing for two or more years. Above the permanently frozen soil is an "active layer" which thaws and freezes each year. Thawing is retarded by the insulating effect of a thick organic layer. The active layer found in the Tanana/Minchumina area ranges from 10 to greater than 60 inches in depth.

Fine-grained permafrost soils may contain up to 50 percent water. They are extremely unstable and easily eroded when the insulating cover of vegetation is removed because water released by the melting ice can cause runoff even on very gentle slopes. Sandy soils can have a fairly high ice content but resist erosion because of their large particle size. Coarse-grained gravelly soils tend to be very stable because they are generally well drained.

Many of the soils and substrates in the planning unit are composed of fine grained materials. North-facing slopes, south-facing toe slopes, valley bottoms, and areas shaded by heavy tree cover are completely underlain by ice-rich permafrost. Complete removal of the shading or insulating vegetation mat results in rapid melting of the ice-rich, fine grained soils and substrates. Rain may greatly accelerate melting. If the vegetation mat is removed to the edge of a water body, silt and organic material may wash into the water. Significant erosion rarely occurs after wildfires in interior Alaska because fires rarely consume the entire organic mat, although slumping and landslides occasionally occur on steep slopes after severe fires.

While wildfires have little effect on watershed values, major erosion frequently results from the use of mechanized fire equipment on ice-rich, fine grained, permafrost soils. Complete removal of all of the vegetation and organic material during fireline construction causes much deeper permafrost melting than occurs in adjacent burned areas. Runoff channels and deep gulleys frequently form, and stream siltation can result.

C. VEGETATION

1. Major Plant Communities

The flora of the Tanana/Minchumina planning area is typical of interior Alaska. The immense area includes nearly all plant communities found in the Interior, ranging from conifer and hardwood forests to alpine tundra. The predominant forest cover types include black spruce, white spruce, hardwood, and mixed deciduous-conifer.

a. Black Spruce Woodland - Black spruce forests with a canopy closure of less than 25 percent, but greater than 10 percent, typically occur on poorly-drained permafrost sites. The understory is dominated by sphagnum moss on wetter sites and feathermoss/lichens on drier sites. Ericaceous shrubs2, dwarf arctic birch, and cottongrass are also important. The trees are often very stunted due to the harshness of the site. These black spruce communities often have a thick organic mat, which surface wets ant dries out quickly in response to changes in relative humidity. This, along with the continuity of fuel over larger areas, allows this vegetation type to burn readily when ignited during dry periods of time, usually with a crown fire. The site will be ready to burn again in 30-40 years, once a moss/lichen layer has developed ln the new black spruce stand.

b. Open/Closed Black Spruce Forest - Black spruce stands with canopy cover greater than 25 percent occur throughout the planning area. Paper birch and tamarack are occasional components. These stands are usually located on slightly drier sites than are woodland black spruce communities, and the trees are often taller. The understory is usually dominated by feathermosses, although lichens may form a nearly continuous mat in some stands. Ericaceous shrubs, dwarf arctic birch, and low willows make up most of the shrub layer. Open/closed black spruce forests burn with a frequency similar to that of black spruce woodlands.

c. Open/Closed White Spruce Forest - White spruce forests with canopy closure greater than 25 percent form large, productive stands on warm well-drained sites, especially along major rivers. White spruce also commonly form "stringers" along smaller streams and around lakes. Paper birch and balsam poplar often comprise a significant part of the tree canopy in these stands.

In open stands, a wide variety of shrubs and herbs dominate the understory, along with feathermoss. Alder, tall willow, prickly rose, buffaloberry, bunchberry, twinflower, and ericaceous shrubs are common. Fire occurs much less frequently in these forests than in the black spruce types. When they occur they tend to have lower intensities, although, occasionally, fires kill white spruce, particularly in older stands.

d. Open/Closed Deciduous Forest - Pure stands of birch, aspen, or mixtures of the two species are common on upland sites in the Interior. Aspen are most common on warm, well-drained sites, and grade into birch on colder, wetter sites. Aspen is an intermediate stage leading to white spruce, while paper birch sites may later be dominated by white or black spruce. A well developed understory of alder, willow, highbush cranberry, and low shrubs is usually present, as well as herbaceous vegetation, mosses and lichens. Fires are infrequent in deciduous forests and generally are low intensity when they do occur. However, these fires often kill the thin-barked overstory, after which a new hardwood stand will quickly reestablish.

e. Tall Shrubland - Tall willow, alder, and shrub birch form dense stands between treeline and alpine communities, and in some riparian zones. The understory varies considerably, consisting of dense grasses and herbs, or mosses and lichens. Fires tend to burn very slowly and with very low intensity on the rare occasions when they occur in this vegetation type.

2Ericaceous shrubs include blueberry, cranberry, Labrador tea, and other shrubs belonging to the taxonomic family Ericaceae.

f. Low Elevation Shrublands - Tall willows form extensive communities in low areas, particularly near the foothills of the Alaska Range. On moist sites the understory consists of a dense feathermoss/ericaceous shrub mat, while on dry sites there may be nearly continuous cover of lichens. The meager fuels and typically moist conditions seldom support fires of any notable size.

g. Shrub Bogs and Bogs - Vast shrub bog communities, dominated by ericaceous shrubs, are found over much of the area. Stunted black spruce and dwarf arctic birch are often scattered throughout. Shrub bogs occur on wet cold sites, generally underlain by permafrost, and have a thick organic mat. This community grades almost imperceptibly into black spruce woodland and low shrublands. On very wet sites, all shrubs disappear and a bog characterized by sphagnum dominates. These areas are often left unburned when large fires burn surrounding, drier areas.

h. Grasslands - Grassy meadows are scattered throughout the area on old lacustrine and glacial deposits. They are generally dominated by bluejoint grass and provide vital habitat for several wildlife species.

i. Tussock Tundra - Tussock tundra, dominated by cottongrass, is found on gentle slopes underlain by permafrost in mountain valleys in the northwest part of the planning unit. Other important species include ericaceous shrubs, mosses, and lichens, and frequently other sedges, shrub birch, and cloudberry. Fires in tussock tundra can burn with high intensity at any time of the summer because of the large amount of dead material. Fires can burn very deeply into the organic mat after a long dry period, but more characteristically consume only the surface organic layer.

j. Other Tundra Communities - Other tundra communities are also found within the planning area, but do not readily burn. Shrub tundra, dominated by dwarf birch, blueberry, labrador tea, and dwarf willow, is fairly common at higher elevations, above the shrub bog communities with their stunted black spruce. Fires which burn into these communities from lower elevations frequently go out because of the moist conditions and sparse fuel. Fires which do burn have very slow rates of spread and low intensity.

The following communities are probably found within the planning unit at higher elevations, although their extent is unknown. Herbaceous tundra, meadow communities dominated by grasses and other herbaceous plants, are found on adequately drained, protected sites. Fires would be infrequent and of low intensity, because of low fuel loading, and summer-green conditions. Sedge-grass tundra is usually too wet to burn, and also has a very low quantity of fuels.

Mat-and-cushion tundra communities are located where harsh environmental conditions limit the development of vegetative cover. Discontinuous low growing mats of vegetation, primarily of dryas species and prostrate willow are found, along with ericaceous shrubs, other fortes, sedges, and sometimes lichens. Fire occurrence is very low because fuels are sparse and discontinuous, and any fire would be quite small.

2. Fire Effects on Vegetation

Fire may be the chief factor maintaining vegetative productivity in cold Alaska soils, in which the lack of nutrients is a major factor limiting plant growth. Most nutrients are tied up in the vegetative overstory and in the thick moss and organic layers, and are unavailable to plants. The insulating effect of the organic mat limits summer warming of soil, and keeps the level of permafrost close to the surface.

Burning organic material changes nutrients from complex forms unavailable for plant growth, to more simple and readily available forms in ash. The soil becomes warmer because the overstory and moss layer have been removed, the organic layer is thinned, and the darkened soil surface absorbs more of the sun's heat. The active layer becomes much deeper, increasing the volume of soil from which plants can extract nutrients. The soil nutrient regime is greatly improved by the increased activity of decomposing and nitrogen fixing organisms. The degree to which these changes occur is closely related to the amount of organic matter removed by the fire, a factor which can vary considerably for different fires and for different areas of a single fire.

The amount of organic layer consumption is the result of an interaction between the organic layer moisture content and the amount of heat released by burning fuel. The depth of burning, fire severity, is much greater if the organic layer has been dried by a long period of sunny weather, than if the fire occurs after only a few drying days. The type and amount of initial revegetation of the burned area will be closely related to the severity of the fire.

The three major means of plant regeneration after burning are: resprouting from the stumps of plants killed by fire, resprouting from lateral roots and rhizomes (buried stems), and plant development from buried or wind carried seeds. The depth of organic material remaining as a mat on the mineral soil will determine which of these means of revegetation will be the most important.

In Alaska forests with deep organic layers, most of the below ground plant parts are found in the organic mat, rather than in the soil. Roots and rhizomes of plants such as blueberry, mountain cranberry, and twin-flower are located in the upper portions of the organic layer, while rhizomes of other species, such as rose, raspberry, and fireweed tend to be more deeply buried. Many of the roots of willow and some of the lateral roots of aspen also grow in the organic mat. Because these plant parts are the source of new sprouts after fire kills above-ground stems, the depth of burn has a great effect on the amount of postfire sprouting, and the species likely to dominate the postfire community. If fire just scorches or burns the surface of the organic mat, killing, for the most part, Just the above-ground stems, rapid and often prolific sprouting occurs from roots and rhizomes of those species found in the surface organic layers. If fire heat penetrates into the organic mat, killing plant parts to some depth but not consuming all organic matter, sprouts may originate from more deeply buried plant parts, and the sprouts may take longer to grow to the surface. Species with more deeply buried rhizomes and roots will be favored over those species which root primarily in the upper organic layer.

Complete consumption of the organic layer removes many or all of these potential sprouting sites, truly killing most plants on the site. A fire which burns away most or all of the organic layer will greatly limit the amount of vegetative reproduction which can occur after fire, but will favor development of new plants from weeds by creating good seedbed conditions.

Most plants of interior Alaskan forests require bare or nearly bare mineral soil as a prerequisite for successful seed establishment. When a seed falls on a blackened, but deep organic layer, it will germinate when there is plenty of moisture, such as after snowmelt or spring rains. However, the seedling will frequently die in a warm summer, because it is rooted in the organic layer which dries out. Because mineral soil retains moisture much longer than organic material, a seed landing on a mineral soil seedbed is much more likely to develop into a mature plant. Also, because postfire sprouting is limited on deeply burned sites, the amount of competition from other plants will be greatly reduced for several years.

A mosaic of fuel, organic layer and soil moisture conditions on a site can lead to a variable pattern of burn severity, and thus favors the development of a vegetation mosaic after the fire. Sprouts, seedlings, and vegetation which survived the fire may all be found. Successful reestablishment of seedlings, however, depends on more than the presence of a suitable seedbed. Other factors are also critical, such as the type and age of prefire vegetation, the time of year when the fire burned, the distance to the nearest seed source, the amount of seed consumed by rodents and birds, and the periodicity of seed crops. White spruce, for example, is physiologically capable of producing good cone crops every two or three years, but the lack of favorable weather for cone formation can greatly increase the interval. A ten year period between large cone crops is not unusual.

3. Postfire Vegetative Recovery

a. White Spruce - Although the amount and rate of postfire revegetation will vary, general successional sequences for interior Alaska forests have been developed. Foote (1980) describes six postfire stages for upland white spruce/feathermoss communities:

1) Newly burned stage - lasts for a few weeks to a year. The forest floor is covered with a layer of charred organic material and ash. Suckers of rose, highbush cranberry, willow and aspen appear first; then seedlings of fireweed, aspen, paper birch, and rarely, white spruce. Red raspberry, and other herbaceous species will be present ln lesser amounts.

2) Herb-seedling stage - (1-5 years postfire). This stage is dominated by shrubs, aspen, and herbaceous plants, particularly fireweed, and Ceratadon and Polytrichum mosses and the liverwort Marchantia, which colonize bare mineral soil. Vegetative cover increases, litter accumulated and a thin organic layer begins to form.

3) Tall shrub-sapling stage - (6-25 years postfire). The overstory is dominated by one to two meter tall willows, prickly rose, highbush cranberry, and aspen, with an understory of herbs, tree seedlings, and litter. The organic layer thickens to about 8 cm.

4) <u>Dense hardwood stage</u> - (26-45 years postfire). Hardwoods form a dense canopy and shade out the shrub understory. As the stage progresses, hardwoods begin to thin, and an understory of small spruce develops. Cladonia lichens are more abundant in this than any other stage, although they are not a significant part of the ground cover. Organic layer depth does not increase.

5) <u>Mature hardwood stage</u> - (46-150 years postfire). These stands are characterized by well developed aspen and/or paper birch, or mixtures of hardwoods and white spruce. Because paper birch trees tend to outlive the aspen by 30 to 50 years, older stands usually contain paper birch or birch/spruce mixtures. Highbush cranberry, prickly rose, twin-flower, and horsetails dominate the understory; leaf litter covers the forest floor; willows, mosses and lichens are not important. The organic layer depth averages 11 cm.

6) <u>Spruce stage</u> - (150 to 300+ years postfire). Mature white spruce dominates, with a few remaining hardwoods in younger stands. Prickly rose and highbush cranberry are the mayor understory species, but may be replaced by green alder in older stands. Twin-flower and horsetails are common. Feathermosses cover the forest floor, over a 12 cm organic layer.

It has been suggested that without fire, some old upland white spruce sites would eventually be replaced by black spruce and bog, or a treeless moss/ lichen association, although others believe that white spruce stands are the final vegetation stage. Substantial evidence indicates that older white spruce stands on floodplains are replaced by black spruce as permafrost develops under accumulating moss and lichen layers.

b. <u>Black Spruce</u> - Postfire revegetation of black spruce/feathermoss sites follows a sequence similar to that for white spruce sites, but the duration and dominant species of later stages differs. Permafrost is close to the surface on most black spruce sites. Fire's consumption of some of the organic layer, and the blackened surface will result in a warming of the soil profile. Depth of the active layer will increase and soil and vegetative productivity will markedly improve. The following sequence of postfire vegetative changes have been detailed by Foote (1980).

1) <u>Newly burned stage</u> - (0-1 year after fire). Within a few days of the fire, sprouts of willow, prickly rose, bog blueberry, bluejoint, labrador tea, cloudberry, and Polytrichum moss appear. Charred materials cover most of the.forest floor throughout this stage.

2) <u>Moss-herb stage</u> - (1 to 5 years postfire). Other species also become important, including black spruce, aspen, paper birch, additional species of willows, resin birch, mountain cranberry, Ceratodon moss and Marchantia, as well as bluejoint, cloudberry and horsetail. The active thaw zone increases greatly during this stage.

3) <u>Tall shrub-sapling stage</u> - (5 to 30 years postfire). Tall shrubs and/or saplings dominate the overstory, especially willow and aspen. black spruce and hardwood seedlings are abundant. Ceratodon moss, fireweed, bluejoint, blueberry, labrador tea and mountain cranberry dominate the low growing vegetation. The active layer reaches its maximum depth, averaging 82 cm.

4) Dense tree stage- (30 to 55 years postfire). An overstory of numerous young birch and/or aspen trees is present, with extensive patches of low shrubs, feathermosses and Cladonia and Cladina lichens. Cover of herbaceous plants and willow has greatly decreased, while resin birch, prickly rose and green alder are still common. The trees begin to self-thin during this period. These stands are highly flammable and frequently burn.

5) Mixed hardwood-spruce stage - (56 to 90 years postfire). A mixed overstory of black spruce, aspen, and/or paper birch dominates. Hardwoods are mature and begin to stagnate and die out. Prickly rose, mountain cranberry, blueberry, bluejoint, bunchberry and feathermosses are the major understory species. The permafrost table begins to advance, averaging 57 cm. below the surface. Many stands burn during this successional stage.

6) Spruce stage - (91 to 200+ years postfire). This final stage has an overstory of black spruce and perhaps a few relict aspen and paper birch. A mid-vegetation layer of green alder, smaller black spruce and sometimes prickly rose overtops the forest floor layer of feathermosses, Sphagnum moss, mountain cranberry, blueberry, and a few herbs. A few Cladina and Cetraria lichens are present. With increasing stand age, sphagnum mounds increase in size, the moss layer thickens, the depth to permafrost decreases, and vegetative growth stagnated, because of cold soils and unavailability of nutrients.

Without fire, wet boggy conditions and a fairly open stand of stunted black spruce will develop on colder and wetter sites. On mesic black spruce sites, stands may increase in density, maintaining themselves by layering and rooting of lower branches, or may decrease in density, with many dead and dying trees and little reproduction. Fire is the only way to restore upland black spruce sites to a productive state.

c. Tussock Tundra - Fires in tussock tundra remove varying amounts of cottongrass, shrubs rooted in the cottongrass tussocks, tussock mounds, and adjacent mosses, lichens and organic matter. Vegetative recovery after most fires will begin within a few weeks, with sprouting of cottongrass, other sedges, shrub birch, ericaceous shrubs, and cloudberry. Because flowering and seed production of cottongrass increase manyfold, seedling establishment occurs on favorable seedbeds. Lightly burned lichens may regenerate from unburned basal parts. After 7 or 8 years, little direct evidence of fire may be visible.

Revegetation on severely burned sites will proceed more slowly. Many cottongrass tussocks will be partially or completely consumed by fire, and less sprouting will occur. Some shallow rooted shrub species, such as mountain cranberry and crowberry, may be temporarily eliminated from the site. Cottongrass reestablishment from seed will be a major means of revegetation. Lichens will initially establish from wind blown lichen fragments which land on moist microsites, but it is not known how many years will be required before lichens regain their prefire abundance.

The tussock growth form is a very important adaptation to these cold sites.

Higher than the general ground level, tussocks receive more sunlight, thawmore quickly in the spring, reach maximum summer temperature sooner, average 6-8°C warmer than soils beneath the surface, and have more favorable nutrient regimes because of the warmer temperatures. The tussock growth form ensures much higher productivity for tussock sedges and associated plants (Chapin, Van Cleve, and Chapin, 1979).

Productivity will decline as sphagnum and other mosses fill in the spaces around the tussocks. Tussocks will no longer receive additional sunlight, so their internal temperature will be as cold as soil temperatures, and growth of most vegetation will stagnate. Some tussocks may eventually be completely buried by sphagnum. Because tundra fires cannot be dated with present methods, it is not known how long this process takes. The effect of sphagnum moss accumulation on tussock tundra lichen production is not known, but it may be detrimental, as it is on black spruce sites.

d. Other Non-forested Sites - Postfire revegetation in shrublands and bogs is primarily by resprouting of shrubs, grasses, sedges, and low growing herbaceous plants. Because these vegetation types are fairly wet, fires rarely burn severely enough to burn all roots and rhizomes. After the rare event that a fire burns deeply into the organic layers, seed reproduction will assume greater importance, and recovery of the prefire vegetation will initially be slower.

Fires in grassy meadows can be intense, but are usually beneficial, even in the short term. Sprouting occurs within a few days. Removal of accumulated litter and darkening of the soil surface promotes earlier snowmelt and greenup and therefore, a longer growing season. Seed production is much greater, and grass production will increase for several years, only declining as litter accumulates to prefire levels. Fire will also benefit meadows by removing or killing back encroaching trees and shrubs.

Postfire revegetation of sedge-grass, and mat-and-cushion tundra has not been studied in Alaska. It is likely that plant recovery will be by sprouting if perennating plant parts are not destroyed. If sprouting sites are killed, recolonization of the small burned areas will probably be from seed, or from roots and rhizomes which spread into the burned area from adjacent living plants.

D. WILDLIFE

1. Fire Effects on Habitat

Fire is a natural occurrence within Alaskan ecosystems. Generally, the effects of fire on habitat are much more significant than the effects on existing animals. Habitat changes determine the suitability of the environment for future generations of animals. Fires may have a short-term negative impact on existing animals by displacing or sometimes killing them or by disrupting critical reproductive activities. However, these animal populations recover quickly if suitable habitat is provided. Generally, fire improves the habitat for a wide variety of species. The adverse effects that the immediate generation of wildlife may experience are usually greatly offset by the benefits accrued to future generations.

Most of the planning area is covered with a mosaic of forest and bog habitat types that have been collectively termed the northern boreal forest. Fire is the primary agent of change in the boreal forest and is responsible for maintaining habitat heterogeneity. Wildlife have evolved in the presence of fire and have adapted to its presence. Indeed, the continued wellbeing of most species of wildlife depends on periodic disturbance of the habitat by fire. Even those species normally associated with mature stages of vegetation are able to accommodate and benefit from some level of disturbance by fire.

The grasses and herbaceous plants that quickly reestablish on burned areas provide an ideal environment for many species of small mammals and birds. A rapid increase in microtine population usually occurs following a fire. This abundance of small prey animals in turn makes the recently burned area an important foraging area for predatory animals and birds. However, the size of the fire and the subsequent proximity to cover, and denning or nesting sites affects the degree of use by these larger animals.

Fire severity and frequency greatly influence the length of time that this grass and herbaceous plant stage will persist. Severe burning delays the reestablishment of shrubs, a benefit to grazing animals and seed-eating birds. Frequent reburning of a site further retards generation of shrubs and seedlings and prolongs the grassland environment.

For some species of wildlife, such as bison, this perpetuation of a grassland environment is beneficial. Where bison are present, a management program that entails periodic burning to preclude invasion by shrubs and trees can supplement the rangeland that is naturally available along the braided river courses.

Browsers such as moose, ptarmigan and hares can benefit from the fire as soon as shrubs and tree seedlings begin to reestablish. If a fire leaves most of the shrub root and rhizome systems intact, sprouting will occur very soon after burning. In the case of early season fires, some forage may be available by the end of the growing season and limited use by browsing animals may occur. Forage quality is much improved, with higher digestibility, protein, and mineral content for some years after fire. As tall shrubs and tree saplings begin to dominate, the site becomes increasingly able to provide shelter and forage for a greater variety of wildlife. Although the rate of regrowth varies among burned areas and is dependent on many factors discussed earlier, this productive stage can persist for as long as 30 years after fire.

The greatest variety of wildlife will be found during the tall shrub-sapling stage. Many species, which up to that point have frequented the burned area only to hunt or forage, begin to find that it provides shelter and denning or nesting sites as well. This abundance and diversity of wildlife, in turn, makes these burned areas extremely important to people, whether it be to hunt and trap or to view and photograph.

On most sites the young trees outgrow the shrubs and begin to dominate the canopy after 25-30 years. At this point the shrub component thins out and changes, as more shade-tolerant species replace the willows. Subsequently, use by browsing animals such as moose, hares, and ptarmigan declines. On mesic sites which are developing into black spruce forest, lichens become important during this period and increase in abundance for 50 to 60 years. As the forest canopy develops and the understory species disappear, a burned site becomes progressively more unproductive. Relatively few animal species can find the requirements necessary for their survival in the mature spruce forest that will eventually develop in the absence of further fire.

Because lichen cover increases in these more mature stages of black spruce stands, these areas are very valuable for lichen foraging animals such as caribou at this stage of development. However, in older stands, lichens are slowly replaced by feather and sphagnum mosses. On valley bottoms where a muskeg bog situation exists, lichen cover also develops but, contrary to the upland sites, lichens may persist as succession advances.

Generally speaking, large, severe fires are not nearly as beneficial to wildlife as are more moderate fires. Lighter fires quickly benefit browsing animals and their predators by opening the canopy, recycling nutrients, and stimulating sprouting of shrubs. In addition, the mature trees which are killed but not consumed by the fire, provide nesting sites for hole nesters such as woodpeckers, flickers, kestrels, and chickadees, as well as some cover for other animals. A severe fire that burns off the aboveground biomass and kills root systems, removes all cover and slows the regeneration of the important browse species, which must now develop from seeds.

Some sites, however, have progressed so far toward a spruce forest community that very little shrub understory exists from which revegetation of the site may occur. Furthermore, many sites are so cold and poorly drained that black spruce have a competitive edge over the less tolerant shrub species. In these situations, a light fire simply results in more spruce. Severe fire, or frequently recurring fires are necessary to kill the seeds in the spruce cones and prepare a suitable seedbed for other species. Then the value of the site to most species of wildlife is enhanced.

2. Wildlife Response to Fire

a. Moose - Moose were formerly much more abundant within virtually all portions of this planning area. Quality of moose browse in much of the area appears to be deteriorating and until fire or other disturbances are permitted to occur, overall carrying capacity for moose will not significantly increase. Fire suppression activities have interrupted the natural fire regime in much of the area to the overall detriment of moose and other species dependent on early forest seral stages.

Moose populations usually increase following fire due to increased production of high quality browse in the burned area. However, if the moose population has declined for reasons other than poor habitat, moose may be slow to utilize new habitat created by burning, and numbers may not increase dramatically. Under these circumstances the remaining moose have little trouble obtaining sufficient browse without utilizing the new burn. Use of a burned area will depend largely on whether it is situated in an area traditionally used by moose or through which they migrate. Dispersal to new areas will be slow. If, however, a fire occurs in an area where the moose population is near carrying capacity of the range, then competition for food and social pressures between individuals will result in more rapid exploitation of new habitat created by a fire. The use of burned areas by moose is also related to the amount of available cover. Fires of moderate size or large fires that contain numerous unburned inclusions create more edge effect than extensive severe fires, resulting in better moose habitat .

b. Caribou- It appears that caribou may not be adversely affected by fire to the degree once believed. The short-term effects of fire on caribou winter range are mostly negative. These include destruction of forage lichens, reduced availability of other preferred species in early postfire succession, and temporary alterations in caribou movements. However, forage quality of vascular plants will be improved by fire.

Long-term effects are generally beneficial. Light fires may rejuvenate stands of lichens with declining production. Fire helps maintain diversity in vegetation type, replacing old forest stands where lichens have been replaced by mosses, thereby initiating the successional cycle which leads to the reestablishment of lichens. Fire creates a mosaic of fuel types and fire conditions that naturally precludes a series of large, extensive fires that may be devastating to caribou habitat. Caribou are nomadic and each herd has historically utilized a range much larger than necessary to meet its short-term food needs. Thus, gradual rotation of the forest system by fire can be accommodated and, as pointed out, may be essential to prevent large severe fires which burn huge portions of a herd's range and result in an immediate lowering of range carrying capacity.

The long-term effects of fire on caribou range may be negative in some cases, however. Fires that recur frequently over a relatively short period of time may result in forests being replaced by grasslands or shrub-dominated communities, although this is not likely to occur over large areas. Also, large severe fires can create monotypes which would lead to irregularity in productivity and abundance of forage lichens.

While historic reasons for the decline in caribou distribution and abundance are not well known, loss of winter range to fire is not a probable cause. Although much of the caribou range occurs in an area of high fire frequency, there is no indication that natural wildfire has occurred more frequently in recent years than in the historic past. In fact, it is likely that less acreage has burned annually in recent times because of improved fire suppression capabilities.

c. Dall sheep - Winter range, lambing areas, and mineral licks are critical elements of Dall sheep habitat. Because the vegetative cover found on sheep range does not carry fire well in most cases, fire normally does not play a significant role in sheep population dynamics. Under some circumstances, fire may enhance sheep range by depressing treeline in areas where the boreal forest has encroached on alpine habitat.

d. Bison - Wildfires are extremely beneficial to bison. The present habitat is maintained primarily by river erosion and flooding; however, fire has the potential for greatly expanding suitable bison habitat away from the floodplain. The grasses and fortes that are the mainstay of their diet quickly reestablish after a fire. Burning serves to stimulate new growth and remove the mat of old material, canoeing earlier green-up. In addition, an extensive severe fire may result in a long lasting grass stage, by killing sprouting trees and shrubs, and tree seeds. Repeated fires can have the same result by killing trees and shrub vegetation before it is mature enough to produce seeds. The August 1977 fire in the Farewell area created new grassy areas which were utilized by bison during the summer, fall, and winter.

e. Black and Grizzly Bears - Black and grizzly bears are both benefitted by fire, responding in much the same way as do their prey species. Both are omnivorous, and fires increase the availability of both plant and animal foods. Blueberries, cranberries, and soapberries increase following fire, particularly in upland areas. Moose calves are important in the diets of both the black and grizzly bears in the springtime. Early stages of plant succession tend to increase moose production, therefore, more calves are available as prey. Small mammals are more readily available and play an important role in bear diets during the snow-free months. The grizzly, in particular, should benefit from increased large rodent populations following fire, although this is speculative and not yet proven. Because black bears make extensive use of lowland marshy areas during spring, fires occurring in such areas should be considered beneficial for this species.

f. Upland Game Birds and Small Game Mammals - Upland game birds and small mammals are also herbivores and as such, generally benefit from the increased forage and diversity created by fires in the boreal forest.

Sharp-tailed grouse prefer the open, shrubby areas created by fire over the dense forest. In the absence of fire sharp-tailed grouse frequent the open muskeg bogs; however, openings created by fire apparently are preferred and are not nearly as limited. Sharp-tailed grouse extensively utilize young burns both for foraging and for essential reproductive activities such as "lekking" (display activity on communal dancing grounds).

Ruffed grouse numbers may be initially depressed by the occurrence of a fire; however, they begin using the burned areas extensively as foraging sites when the sapling stage develops. Most researchers believe that the overall effects of fire upon ruffed grouse are beneficial and that fire may indeed be essential for the maintenance of healthy populations of ruffed grouse in the boreal forest.

Fires in ptarmigan summer habitat are a rare occurrence, since breeding occurs in the alpine areas at higher elevations. However, fires near treeline could increase ptarmigan nesting habitat by removing spruce trees that are encroaching on alpine tundra sites. Because most ptarmigan migrate to lowland areas for the winter months where their primary winter foods are young willow and birch, fires in the boreal forest can improve habitat for ptarmigan.

Spruce grouse appear not to be benefitted by fires because of their preference for mature coniferous forest habitat. Changes in habitat that affect availability and suitability of nesting areas, brood rearing areas, feeding places or roosting sites would greatly impact spruce grouse.

Snowshoe hares normally prefer older stands of black spruce and thick alder tangles during lows in their 10-year cycles. During population highs, however, hares will use even severely burned areas. Hares normally use open areas during summer months when their diet consists largely of herbaceous plants and leaves from low shrubs which are more abundant and nutritious on recently burned sites. Small fires or large fires with numerous unburned inclusions of black spruce or other heavy cover should provide optimal habitat for hares.

g. Aquatic Furbearers and Waterfowl - When fires occur in riparian (streamside) areas and marshes, they can be beneficial to muskrat, beaver, goose, duck, and swan populations. Without fire, ponds will usually be filled in by marsh vegetation. Organic matter accumulation will then favor the establishment of shrubs and trees. Fire rids marshes of dead grass, sedges, and shrubs and thereby tends to open up dense marsh vegetation to a degree that suits feeding waterfowl. Burning also stimulates the growth of new shoots which are of greater forage quality. Fire can have a short term negative impact when it occurs during nesting or molting periods.

Fire also is an important factor in the maintenance of marsh systems. In dry summers, peat marshes can burn down to the point where new bodies of water are created. Burning also alters the insulative effect of old marsh vegetation and allows solar heat to penetrate and alter the marsh subsurface where permafrost or ice lenses are prevalent. Subsequent melt-outs can result in new ponds and altered vegetative cover.

h. Terrestrial Furbearers - The furbearers other than beaver and muskrat are carnivorous and tend to respond to fire in a manner similar to that of their primary prey population. Some predators such as lynx are very specific, concentrating their efforts toward securing snowshoe hares. Others such as the red fox are less specific and are able to thrive on a variety of prey species such as rodents, hares, birds, and even fruits and berries at certain times of the year.

Because of their extremely large home ranges, wolves should not be harmed by fires of small or moderate size and will derive benefits from such fires as habitat conditions develop that favor prey species. Extremely large fires in caribou winter range, however, may cause changes in caribou migration routes and choice of wintering areas. In that case, wolves would also be forced to cease using the area, or switch to alternate prey species.

Fire probably benefits wolverine in most cases because ample food sources are apparently their key habitat requirement.

Red foxes have been characterized as animals of open grasslands and low shrubs, subsisting primarily upon rodents and hares. Therefore, depending upon the numerical response of red-backed and meadow vole populations on a site, the first 10 to 20 years following fire should benefit red foxes.

Lynx appear to prefer the same habitat types as snowshoe hares, their primary prey; therefore, fires which benefit hares by increasing browse production in association with adequate cover will also benefit lynx. Numerous small fires with numerous unburned inclusions should create optimal conditions for hares and lynx.

There is a common assumption that all fires are detrimental to pine marten populations, and intense fires do remove large trees which provide denning habitat. However, at the same time the food base for marten may be expanded. The food preferences are broad and marten are not dependent upon a particular prey species. Mice and voles constitute the main source of food, along with birds, squirrels, and berries. The frequently voiced assumption that martens depend heavily upon red squirrels probably is not valid in Alaska.

Large fires that result in extensive replacement of mature spruce with aspen and birch are decidedly detrimental to marten. Marten usually abandon these burned-over sites. However, the mosaic created by small fires or fires with unburned inclusions of spruce probably benefit marten populations more than they harm them. Cover and denning sites are retained in the unburned portions, while nearby foraging areas (openings created by fire) are improved.

Both the least and short-tailed weasel benefit from the increased prey abundance that usually follows burning.

Coyote populations are benefitted by fires that result in many openings within the boreal forest or which result in replacement of forest with grassland.

i. Small Mammals and Birds - Fires either benefit most small mammals or cause only temporary declines in their populations. Because vegetative recovery enormously increases available biomass on burned areas, population declines are more than compensated for in a short time. Red-backed voles, a species known to inhabit mature black spruce forests, will quickly exploit newly burned areas adjacent to mature stands of black spruce. Meadow voles often will begin using the same burned area in about the third year. Peak rodent densities in one study occurred when environmental conditions could be tolerated by both red-backed and meadow voles 7 to 16 years following fire. The implications of these observations are that predators largely dependent upon rodents will derive maximal overall benefits from a fire during that period of rodent super-abundance.

Although most small mammal species thrive best in very early seral stages of vegetation a few, like the red squirrel and flying squirrel, are adapted to old-age coniferous forests. These squirrels are dependent on white spruce for food and cover, and would be adversely affected by fire.

The habitat requirements for passerine birds varies greatly. Some like the pine grosbeak are specialized seed eaters that prefer spruce forest. However, most species frequent younger seral stages of vegetation and are most abundant in areas of greatest plant diversity. All burned areas will not be the same age nor size in an area with a history of fire, nor will conditions in like-age burns be the same because of differences in prefire vegetation, and fire severity. This presents a diverse vegetative mosaic that will support a wide spectrum of bird life. Extensive stands of black spruce present a rather narrow set of environmental conditions which restricts the number of bird species which can inhabit such areas.

Studies of songbirds in relation to fire in the north are scarce; however, one study (Klein, 1963) graphically demonstrated the changes that can occur following fire in the boreal forest. After burning of a white spruce forest in Alaska in 1948, only 19 birds of 7 species were seen during 20 hours of observation. By 1957, 9 years later, nearly 200 birds of 19 species were seen, but by 1961, 13 years later, only 16 species were observed. Woodpeckers were well represented because of insects in the fire-killed spruce.

j. Raptors - Hawks, owls, eagles, and falcons generally benefit from fire. Small raptors that feed on mice and voles benefit most rapidly, since the herbaceous vegetation that is preferred by these small rodents returns to a burned site quickly after a fire. Raptors that specialize in preying on hares, grouse and ptarmigan benefit the most when shrubs and sapling trees invade the burned site. Small fires or large fires with many unburned inclusions would generally be best because of the vegetative mosaic that would result. The sharp-shinned hawk is probably the only raptor in Alaska that might be adversely impacted by fire. These hawks forage in the scrubby, open black spruce muskegs and prefer spruce trees for nesting sites. Other raptors are not nearly so restrictive in their foraging and nesting requirements. Golden eagles, great gray owls, great horned owls, boreal owls, goshawks, and hawk owls will nest in conifers, but neither require them nor necessarily prefer them. Kestrels, hawk owls, and boreal owls nest in tree cavities created by nesting woodpeckers. Burning produces standing dead trees that are readily utilized by woodpeckers, flickers, and other hole nesting species. Other raptors such as short-eared owls and harriers forage and nest in grassy meadow situations which are usually created and maintained by fire.

k. Fish - Fire effects which can directly impact fish populations are increased siltation and increased water temperature. Indirectly, any alteration of the nutrient flow which adversely affects aquatic organisms will also in turn affect fish populations.

Very little surface erosion normally occurs on burned sites in interior Alaska (except where heavy equipment is used to suppress the fire); thus, stream siltation is usually negligible. The few studies which have been conducted on fire effects on stream temperature indicate no postfire increases in the temperature of streams within a burned area. Thus, fish species which are adapted to the cold water in Interior streams are not likely to be affected. Burning also does not seem to adversely impact the aquatic fauna in the Interior.

Fire has the potential for initiating other changes in a riverine system. A stream that coursed unimpeded through white spruce before a burn, may become dotted with beaver colonies 10 to 20 years after a fire. Beaver ponds provide excellent rearing waters for salmon fry and can also benefit grayling and pike. On the other hand, beaver dams may restrict fish migrations and could temporarily result in the absence of grayling from the upper reaches of some streams. Probably in most cases the presence of beaver ponds is beneficial to the fish resource of the area and should be viewed as a positive attribute of fire.

E. THREATENED AND ENDANGERED SPECIES

1. Animals

The only listed endangered animal species that has known distribution and occurrence in the planning area is the peregrine falcon (*Falco peregrinus anatum*). Since known nesting sites generally occur in areas where actual burning of vegetation is unlikely (i.e., cliff faces and rock outcrops), the potential for burning of nest sites or mortality to the bird or its young is fairly remote.

Fire has long-term beneficial effects for peregrines because it provides successional vegetational changes and diverse habitat for prey species. Fire improves waterfowl production in wetland habit. Diverse habitats and increased vegetation productivity provide numerous niches for small bird populations which may provide for an improved prey species base for peregrines as well as other raptor species.

The effects of fire suppression and related activities are considered to have more adverse impact on sensitive, threatened, and endangered species than the actual fire. Human activities, such as the construction of fire breaks, crew camps, use of vehicles, retardant drops, ant low flying aircraft, which occur near peregrine falcon eyries, would contribute to disturbance of nesting birds and increase the likelihood for nest abandonment or mortality to young.

2. Plants

Four taxa proposed for threatened or endangered status (Murray, 1980), have been located within the planning unit. Three of these taxa - *Smelowskia borealis var. villosa*, *Smelowskia pyriformis*, and *Taraxacum carneocoloratum* are found on high, dry alpine ridgetops. The low fire potential in these areas minimizes the risk of destruction by fire, and the inaccessibility of the mountain summits precludes their consideration as staging areas for fire equipment or personnel. The fourth taxon, *Oxytropis kokrinensis*, is found in the Ray Mountains at the northern boundary of the management area. The fellfields of the low, rounded hills on which this species occurs provide more suitable fire fighting staging areas and their utilization could entail disturbance to the oxytrope. While the general distribution of the species in the Ray Mountains is not yet known, it is believed to be sufficiently extensive to withstand some disturbance to local populations. For this reason, *Oxytropis kokrinensis* does not warrant specific protection at this time, but the likelihood of its presence should be noted.

F. HUMAN VALUES AND ACTIVITIES

1. Wilderness

Denali National Park contains the only designated wilderness within the planning area. As a natural ecosystem process, fire will increase the suitability of any area for wilderness designation by Congress. The opportunity for primitive recreation and solitude could even be enhanced. Conversely, the use of bulldozed firelines could effectively remove an area from wilderness consideration, making any such activity extremely undesirable.

2. Cultural/Historic Resources

Cultural resources are the prehistoric and historic evidence of human activities. In addition to physical remnants, cultural resources can be found in oral accounts and customs passed down through the generations, and in lifestyles and lifeways that continue to be lived. Because fire suppression is only a very recent activity of humans in Alaska, most cultural values, especially lifeways, have evolved in fire-dependent environments. Some aspects of the cultural heritage in the planning area have been significantly influenced by fire, since fire has played a major role in the vegetation ant wildlife resources that contribute substantially to those lifestyles, customs, and cultural styles.

The planning area contains a variety of known cultural resources, including archeological sites thousands of years old, native cemeteries, former community sites, and travel routes associated with native heritage. Evidence of more recent human settlers includes cabins, roadhouse sites, mines, trails, and tools and equipment associated with European explorers and settlers.

Although some surveys have been done and others are ongoing, only a relatively small portion of the planning area has had extensive investigation for cultural resources. Until surveys can be completed, all cabins and other remains must be considered culturally valuable. The only National Register sites currently listed are all cabins and roadhouses associated with the Iditarod Trail, which is the first National Historic Trail in the United States.

In assessing the impacts of fire and fire suppression activities on cultural resources, it is advisable to draw a distinction between surface and subsurface resources. Surface resources are primarily historic in nature and tend to be constructed of flammable materials, because natural processes of deterioration have not operated long enough to level structures. Subsurface resources are primarily prehistoric and archeological, and tend to consist largely of nonflammable material because natural processes of deterioration have eliminated most organic matter. Furthermore, subsurface resources tend to be much less visible than surface resources, because structures have been leveled and the material covered by vegetation.

a. Effects of Fire - Information concerning the effects of fire and fire suppression activities on cultural resources is scanty. Some information has been gathered concerning fire effects in the lower 48 states, but any attempt to generalize from this data to radically different conditions in Alaska would not be justifiable. Nevertheless, logic and reason would seem to indicate that surface historic structures are subject to severe effects from fire itself. Organic materials used in construction are likely to be completely destroyed or substantially damaged as a result of burning.

Subsurface resources are much less likely to be significantly affected by fire. In a very severe fire, which burns down to mineral soil, organic material such as bone, ivory, and wood that is present in the soil matrix will be destroyed. Intense heat from such a fire is also likely to fracture and otherwise damage non-organic material such as ceramics and chipped stone. Because of well-developed vegetation mats and generally moist soils, fire in this region does not usually burn extensive areas to mineral soil. In this case, severe impacts to subsurface cultural resources are very unlikely. Much of interior Alaska is known to have burned in the past. Evidence of such burning has been observed on several archaeological sites that have been excavated, apparently with no evidence of severe impacts from the fires.

b. Effects of Fire Suppression - The possibility of damage to surface cultural resources from fire suppression activities is relatively slight. This is particularly true of standing historic structures which can be easily observed, even by untrained individuals. Consequently, it is likely that most suppression activities such as fireline and camp construction can be located so as to prevent impacts to surface cultural resources. Surface sites such as lithic scatters will be disturbed by fireline construction and similar ground-disturbing activities.

Subsurface cultural resources are likely to be damaged by suppression activities, particularly firelines. Such resources are difficult to observe, particularly in regions such as the Tanana/Minchumina, where well-developed vegetation mats obscure them, making it likely that such sites will not even be discovered until after they have been disturbed.

3. Visual Resources

The effect of fire on the visual resource is primarily beneficial but can be adverse in areas of high visual sensitivity. In general, areas of high visual sensitivity correspond to major travel corridors and population centers. Major access corridors which may be visually sensitive include the Yukon, Kuskokwim, and Tanana Rivers, roads, major aviation routes, and the Iditarod Trail.

Wildfire is an integral part of the ecological process that maintains or enhances natural visual diversity. In the short-term, a small fire (up to 50,000 acres), blackens an area creating sharp visual contrast and possibly visual interest. Extremely large, severe fires (over 50,000 acres) with few unburned or less severely burned inclusions, create large expanses of blackened landscape which are monotonous and result in reduced visual interest. Extensively burned areas will have a negative visual impact on some users (viewers), although others will view the scene positively, or make no value judgment. Even large burned areas may create a pleasing visual effect once vegetation regrowth has begun.

Fire suppression can cause highly adverse damage to visual resources. Short term impacts are generally acceptable unless viewed from key observation positions such as highways, high use areas, or scenic overlooks. Long-term impacts are unacceptable and are usually a result of bulldozed firelines. Bulldozers disturb the organic mat and expose mineral soil, creating distinct unnatural lines across the landscape, and sharp color contrast that may take decades to disappear.

4. Air Quality

The inevitable fate of vegetation is decomposition and eventual incorporation into soil. During a very short period of time while a fire is burning, processes of oxidation and chemical transformation occur which are similar to those that slowly occur in decomposition, with the concurrent production of some materials that go into the atmosphere and are eventually returned to the vegetation system. There is a great chemical similarity between the products of combustion of forest fuels and the products of decay. A summary of emissions (Figure 2) from forest burning indicates relatively large amounts of carbon dioxide, water, particulates, and carbon monoxide. Lesser amounts of hydrocarbon and nitrogen oxides, and essentially no sulfur oxides are produced from forest fires (Martin, 1976).

There are substances, termed and regarded as "pollutants," which emanate from forest burning and enter the atmosphere. Carbon dioxide (CO_2) and water (H_2O) emissions are not considered pollutants. Carbon monoxide (CO) is toxic and lethal concentrations of CO have been found in the active part of some fires. High CO concentrations at the fire site decrease rapidly in any direction to ambient conditions. The burning of forest fuels contributes only 1/600 of the total CO emitted from other natural sources. Unsaturated hydrocarbons (HC) of low molecular weight are related to Los Angeles-type photochemical smog. Hydrocarbons known to be photochemically reactive are present in wood smoke but, with the exception *of* ethylene, in very small amounts. Hydrocarbons are extremely widespread in the plant world in volatile oils, waxes, and resins. The most prevalent HC in the atmosphere is methane (marsh gas) which originates primarily from the decay of organic material. The relative importance of HC emitted from forest fires, as far as photochemical smog is concerned, appears to be very small. Nitric oxide (NO) is also regarded as an important pollutant because of its involvement in photochemical smog processes which may produce damaging compounds such as ozone (O_3) and peroxyacylnitrates. NO is not a combustion product, but forms when air is heated higher than 2800E F. On a global basis, natural production of NO, mostly by soil organisms, exceeds man's production by 15 to 1. Forest fires are an insignificant source of NO. There is no evidence that the emissions from combustion of forest fuels are a threat to human health (USDA Forest Service, 1976).

The visible column of smoke from a forest fire contains a lot of water, very small aerosols of organic matter, and some unburned carbon in finely divided form. The water condenses on the particulates, forming a cloud of water droplets. The total accumulation of particulates or aerosols from burning wood is very small in comparison with that emanating normally from forests. The principal valid objection to the burning of forest fuels as regards particulate pollution is the temporary interference with visibility. Military, commercial, recreational, and even fire detection and fire suppression aircraft activities can all be adversely affected by smoke. However, data from the Alaskan interior indicate that smoke conditions severe enough to impact aircraft (visibility reductions to 6 miles or less) do not occur to the extent generally assumed (refer to Table 1). Yearly occurrences of heavy smoke range from an average of about 6 days per year at Tanana to about 2 days per year at McGrath. Even when heavy smoke is present, it is rarely (less than 40%) so severe as to exceed the Visual Flight Rule (VFR) weather minimums for aircraft within a control zone airspace and very rarely (less than 15%) exceeds VFR minimums for areas outside of control zone airspaces. The historical occurrence, extent, and duration of heavy smoke in the interior of Alaska indicate the problem is minimal.

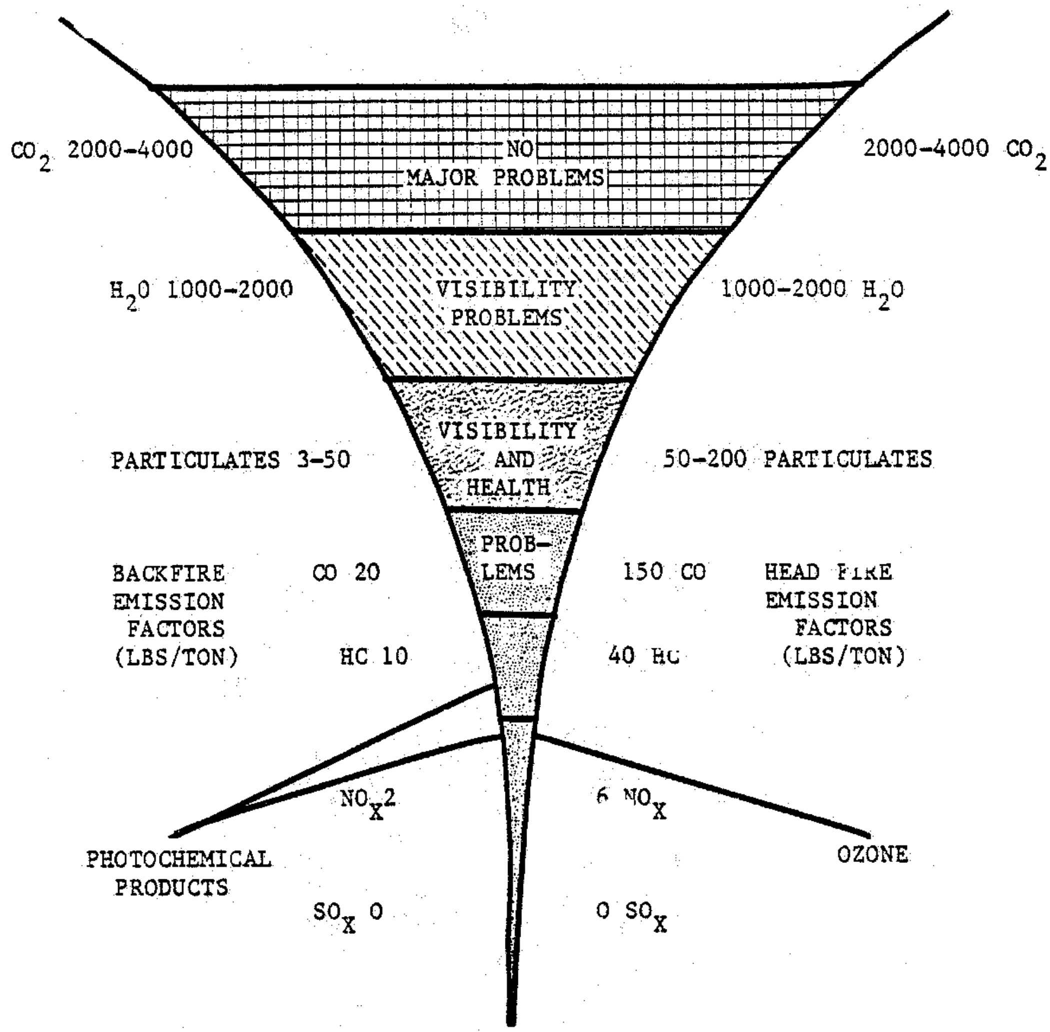


Figure 2. Range of emission factors from forest burning. Because difficulties in sampling and the complexity of the problem, estimated levels of emission factors may vary greatly from these data. (Figure is adapted from that of P. W. Ryan, Southern Forest Fire Laboratory, USDA Forest Service, Macon, Ga. Figures for emissions of carbon dioxide, water, and particulates have been modified.)